DOCUMENT RESUME

ED 432 576 SP 038 702

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TITLE Preservice Teachers' Assessment of Student Understanding: Processes and Their Development.
PUB DATE 1999-04-22
NOTE 29p.; Paper presented at the Annual Meeting of the American Educational Research Association (Montreal, Quebec, Canada, April 19-23, 1999).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Elementary Education; Elementary School Students; Elementary School Teachers; *Evaluation Methods; Higher Education; *Knowledge Level; Preservice Teacher Education; Professional Development Schools; *Student Evaluation; Student Teacher Attitudes; *Student Teachers; *Thinking Skills
IDENTIFIERS Knowledge Acquisition; Knowledge Development

ABSTRACT

This study of eight elementary student teachers used stimulated recall interviews to investigate their knowledge and processes in reading their students, or informally assessing their students' understanding during instruction. By collecting data from four student teachers in each of two different programs at the same university, one of which was a Professional Development School, the study explored factors essential to developing these skills and knowledge and the role of the program in this development. Study results clearly described the general model of assessing student understanding, which emphasized student understanding, gathering various types of cues from three sources, and interpreting the cues in terms of student understanding. Results exposed the thoughts and knowledge necessary for assessing student understanding by defining the general categories of knowledge needed for deep interpretation of cues and describing the complex thinking employed by relative experts. The study proposes that this complex thinking is dependent upon knowledge of classroom routines so that cognitive space is available to attend to assessment issues. The study explains how the assessment processes and knowledge are learned. It also proposes that stimulating classroom experiences and coursework focused on student assessment helped student teachers learn the requisite knowledge, develop a template that facilitated gathering and interpreting cues, and develop routines that allowed cognitive space to focus on cues and integrate forms of knowledge. (Contains 17 references.) (SM)

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Preservice Teachers' Assessment of Student Understanding: Processes and Their Development

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Paper presented at the Annual Meeting of the American Educational Research Association

Montreal, Canada

April 22, 1999

SP038702

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PRESERVICE TEACHERS' ASSESSMENT OF STUDENT UNDERSTANDING: PROCESSES AND THEIR DEVELOPMENT

INTRODUCTION

This study of eight elementary student teachers used stimulated recall interviews to investigate their knowledge and processes in "reading" their students (Hunt, 1981), or informally assessing their students' understanding during instruction. Through collecting data from four student teachers in each of two different programs at the same university, one of which was a professional development school, the study also explored the factors essential to developing these skills and knowledge, as well as the role of program in this development. This paper discusses these findings and describes relative expertise in interactive assessment of student understanding. Implications for teacher education programs are drawn, and suggestions for further study are given.

THEORETICAL FRAMEWORK

Educational reform based on a perspective of learning as actively creating one's own meaning rather than passively accumulating information focuses the teacher's role on facilitating student understanding rather than disseminating information (Holmes, 1990; Pechman, 1992). In this role, it is critical that the teacher comprehend the students' understandings of the lesson so that the lesson may be adapted on the spot to guide development of the students' conceptualizations. Thus far, research in this area has centered on teachers' knowledge of their students' subject-specific understandings (Ball, 1996; Schifter, 1996). Little is known about the more general processes used by teachers to determine these student understandings during the lesson. Even less is known about how these processes develop. With today's increased pressure on teacher preparation programs to efficiently educate more effective beginning teachers, information about the development of teachers' interactive assessment of student understanding of the lesson is needed to help teacher education programs foster development of this skill.

This study of preservice teachers' interactive assessment of student understanding was based on a cognitive perspective of learning to teach which posits that preservice teachers develop more complex, elaborated schemata as they develop expertise in teaching (Borko & Shavelson, 1990). A significant aspect of this cognitive development is the formation of a template, or mental picture, of a typical class and classroom (Berliner, 1989). Support for this cognitive perspective came from research on teachers' interactive decision-making and on differences between expert and novice teachers which described qualitative differences in experienced and novice teachers' processing and use of information about their students. Compared to novice teachers, expert teachers are better able to "make sense" of classroom stimuli (Berliner, 1987), and they have more classroom routines in place (Leinhardt & Greeno, 1986) which enable them to focus more on student learning. In addition, experienced teachers are more adept at eliciting, observing and deeply interpreting student verbal and nonverbal cues (Berliner, 1987; Lawes, 1987; Pinnegar, 1989; Martin & Reynolds, 1993; Tan, 1996). This study assumed that these more proficient practices of experienced teachers were due to their more highly developed schemata.

Little evidence exists concerning the factors that affect the development of these more elaborated schemata. Despite the mixed results of research on the effects of field experiences on learning to teach (Guyton & McIntyre, 1990), educators commonly assume that teaching experience will foster such development (Peterson & Comeaux, 1987), particularly with reflection upon that experience (Berliner, 1987). Advocates of professional development schools (PDSs) rely upon expanded experiences in exemplary classrooms and reflection upon that experience, as well as closer ties between theory and practice afforded by partnerships of school and university faculty in teacher preparation programs, to develop the knowledge and skills indicative of such higher cognitive development (Holmes, 1990; Goodlad, 1990). This study explored the development of knowledge and processes used in interactive assessment of student understanding, particularly the influence of the preparation program, through investigating the assessment processes used by preservice teachers in two programs, a traditional campus-based program and a professional development school.

METHODS

Student teachers from two preparation programs at the same university participated in this study. One program was a traditional program, which required 50 hours of classroom observation at the beginning of the program and 56 hours of supervised field experiences in conjunction with four campus-based methods courses. These preservice teachers had a 15 week student teaching experience at the end of their program; they were supervised by student teaching faculty. University methods courses professors were involved minimally in the schools in this program, visiting the school only to supervise their students during field experiences connected with their methods courses.

The second program was based at two professional development school (PDS) sites. Preservice teachers in the PDS program at both sites were involved at their professional development school for three semesters, including their student teaching experience. They completed 385 hours of supervised field experience at the PDS site before student teaching for 10 weeks. The PDS students at one site were supervised by one of their methods courses professors during their student teaching. The PDS students at the other site were supervised by student teaching faculty. University and school faculty collaborated to some degree at the two sites in teaching and supervising the preservice teachers, and university faculty occasionally taught elementary students in the elementary classrooms. However, both PDSs were in their first year and had not yet forged strong partnerships, so the disparity in the extent of time in classrooms was the major difference in the two programs.

Four female student teachers (STs) from each program participated in this study. To obtain information about each ST's thoughts during the lesson about her students' understanding of the lesson, two stimulated recall interviews (SRIs) with each ST were conducted immediately following whole class lessons. The SRI procedure involved videotaping the *class* while the ST was teaching and then showing the videotape of the class to the ST after the lesson to prompt her recall of her thoughts about the students, the cues she used and her interpretation of them during the lesson. The SRI interviews were accompanied by preactive and postactive interviews which explored the ST's goals and expectations prior to the lesson and her reflections upon the lesson afterwards. These data were gathered toward the end of student teaching to give the preservice candidates

maximum time to benefit from their programs and to learn to assess their students' understanding.

Other data collected concerned the development of the ST's knowledge and processes in reading students. Information about each ST's experiences prior to and during her program as well as about how she learned to assess her students' understanding was gathered through separate, initial semi-structured interviews with each ST. Semi-structured interviews with the cooperating teachers also provided information about the STs' learning. Finally, data about the characteristics of the two PDS sites were gathered through semi-structured interviews with the cooperating teachers, principal, and one university faculty member involved at each PDS site.

A qualitative analysis of the verbal protocols from the interviews was performed. Using codes that emerged from the data, the data were coded and then displayed in matrices for development of themes (Miles & Huberman, 1994). Patterns were sought for individual STs, within the two groups of STs, and across all the STs. Several measures, including use of a "check coder," triangulation of data, "fitting" themes back to the raw data, and consideration of alternative hypotheses, were used to ensure trustworthiness of data analysis (Miles & Huberman, 1994).

FINDINGS

This study yielded information in two main areas: the knowledge and processes used by the STs in their interactive (during instruction) assessment of their students' understanding, including characteristics of relative expertise in this area; and the factors, including program, which contributed to the development of this knowledge and skill. The knowledge and processes used by the STs are described first.

Knowledge and Processes in Interactive Assessment of Student Understanding

Two themes were evident concerning the knowledge and processes used by the STs in their interactive assessment of students' understanding. First, all of the STs employed a

basic model for interactive assessment of student understanding which consisted of deliberately managing the lesson to observe and elicit five types of cues from three sources, individual students, the class, or a few students, and interpreting these cues through using several types of information. Second, individual STs differed in their degree of relative expertise in assessment of student understanding. Each of these themes is discussed in more detail.

First Theme: A Basic Model for Interactive Assessment of Students' Understanding

All of the STs were concerned with assessing their students' learning during the lesson. Further, all utilized the same basic model for interactively assessing their students' understanding: they elicited or observed five categories of cues from three sources and interpreted them to determine whether individuals and/or the class was understanding the lesson. Some individual differences in the STs' specific usage of parts of this process will be mentioned briefly in each of the following subsections. More important differences distinguished levels of expertise and will be more completely explained in the description of relative expertise. This section will focus on the basic process used by all.

Five Categories of Cues

In analyzing the data pertaining to the verbal and nonverbal cues observed and elicited by the STs to assess their students' learning, two major findings were apparent. The first is that all the STs perceived and interpreted cues, or signals, from their students as their main strategy for determining the status of student learning while teaching. This was evident in the STs' focus on these student signals during the SRIs. The STs usually described some type of cue in explaining how they made inferences about their students' learning during the lesson, as demonstrated in the following excerpt from Alex's first lesson:

Alex: I think he kind of was like, "Huh? Okay."
R: And what told you that?

> A: Just the way his face looks, expression and he like just like sits there. And, he'll say something, he might mutter something. I think he did, he'll do something more so than anyone else in the class. There's also a couple others that'll go, "Oh I don't get that!" They'll come right out and say it but they didn't do that. (Alex, 4/3/97).

The second finding is that all the STs used verbal and nonverbal cues from five categories in their assessment of students, and they all used two methods of obtaining them, eliciting (actively prompting) or observing. The verbal cues were classified into three main categories: student comments and questions, student answers, and choral responses. The nonverbal cues consisted of two types, work and physical cues. Certain types of cues were always elicited, such as student answers and choral responses. Some types were always observed, such as student comments. Other types of cues, such as physical and work cues, varied by the specific cue. A brief description of the types of cues will clarify this important step in the process of assessing student understanding.

Physical cues. Physical cues were nonverbal cues noticed by the STs in the student's actions or expressions. One common type was raised hands, particularly how many hands were raised. Another common type was facial expressions, as exemplified by this excerpt from Stefanie's second lesson where she stated, "And just by the way they were looking at me so confused while I was doing the lesson, like 'What are you saying? I don't understand.' " (5/6/97). Other examples were where the students were looking, such as at the teacher or "looking around," and body posture, such as turning around, wiggling, fidgeting, being "antsy," or "just sitting there," as well as gestures, such as yawning, nodding, and shaking heads. At times STs also noted what students were doing, such as following along in the book, writing answers, flipping through the book, or playing with objects. All STs used physical cues in every lesson.

Verbal comment cues. The only cues other than physical cues that were used in every lesson by every ST were student comments. These cues were student comments or questions directed toward the teacher or overheard during whole class or small group discussion that were observed, not elicited as answers to specific questions. Most of these comments and questions concerned the content of the lesson, and the STs listened

carefully to them to determine what students understood. For example, in her second SRI, Sue discussed a student's comment about shapes.

> Kevin's comment said, "Well it's also a rectangle. A square is a rectangle." And then that whole, the thing you get into. A square can be a rectangle but a rectangle can't be a square. It was like, "He's been introduced to this before." And just getting some understanding from these kids where some of them are at with this. (4/21/97)

STs also noted student comments or questions that told them directly that students did not understand the lesson. For example, Stefanie overheard students saying, "I don't get it" twice in her second lesson.

Verbal answers to questions. This category of verbal cues contained elicited student answers to specific questions. These were individual responses; whole class, or choral responses were classified in a separate category. The STs elicited these answers in two ways. The first and most common way was to pose questions about the content to an individual or whole class during the lesson. An example of this was Kess's question during her second lesson when students were reading numbers in the thousands, "What is this number?" The answer cues, of course, were the students' attempts to read the number. The second method of eliciting student answers was to ask an open-ended question prompting a student to explain a process or concept. One commonly-used form of this prompted explanation was to have students explain the steps of a mathematical process. For example, in her first lesson, Hilary prompted individual students to lead her through the process of exchanging 10 ones for one ten by asking, "What do we do now?" at each step of the process. The answer cues in this case were the student's directions to Hilary to complete that step. Another form of prompted explanation that was used less often was asking individual students to explain their process or thinking. For example, in her second lesson, Sue asked a student, "Well how do you know?" to check on the student's thinking about why two shapes were identical.

As with student comments, the STs listened carefully to student answers to determine what the students understood about the lesson. Occasionally, STs used various qualities of the answers, such as speed, clarity and tone of voice, for information about student understanding. In her second lesson, Rachel remarked, "They told me they were

struggling because they weren't giving me a quick response. They were having to think really long about their answer" (4/2/97). The STs also used lack of response as a cue that students did not understand. For example, when Stefanie asked a student, "Two times what is twelve?" in her second lesson, she noticed, "She sat there and she thought. And she didn't know" (5/6/97).

Choral responses. Choral responses were verbal answers elicited from the class as a group and included short answers to questions or problems as well as words repeated after the teacher. For example, Beth called for a choral response when she asked the class if "bappen" was a real word in her poetry lesson. The students answered "no" as a group. The STs listened for several aspects of these choral responses. Obviously, they noted whether students gave the correct answer. They also noted how many students responded, sometimes comparing the number of responses at different times, as Rachel demonstrated in this quote from her second SRI, "And then it showed up there with the 'sing' and the 'thing' because more of them chimed in then. And I was looking for that" (4/2/97). Some STs determined how many students answered by how loud the choral response was. Others noted whether the response was in unison or if some students echoed the rest, as in this quote from Beth's first SRI:

> And it was pretty much in unison, too. It wasn't just like kids going, hearing what their neighbor said and "more than, more than." It almost more an in unison response. And so that's what I was thinking also was okay are they all saying this together so that they're not copying the person sitting next to them, what they're saying. (5/1/97)

Stefanie and Beth recognized that asking students if they understand might result in some answering "yes" "just to go along with the crowd" or "maybe not to look stupid by saying 'no' " (Stefanie, 5/6/97). The STs used choral responses as a quick way to check class understanding without slowing the momentum of the lesson.

Work cues. Work cues were nonverbal cues gathered through observing how students completed tasks as well as checking work the students produced. The tasks and work used to obtain these cues included small group work, work at the chalkboard, holding up answers to problems, and individual completion of written assignments

during class. Although these tasks and work were portions of the lessons planned as practice for the students, the STs also deliberately used them to assess individual student understanding.

Several cues were used to determine student understanding of the lesson. The most commonly used cue was whether students were following correct procedures or giving correct answers, as when the STs glanced at their students' worksheets to make sure the answers were correct. Another commonly used cue was noting how quickly students worked. A third cue mentioned by some STs was simple completion of the task or assignment. As Beth said in her first SRI, "I did notice that everyone was doing it" (5/1/97). Some STs watched specific students who usually had difficulty in that content area.

Using Cues. All of the STs used cues to gather information about students' understanding, although they did not all use the same categories of cues to the same extent. This variance in cue usage did not appear to be a characteristic of an individual ST's practice; rather, the specific cues used in each lesson depended upon the goals and activities of the lesson. For example, student comments were used the most in large group, open-ended discussions while work cues were used mostly in mathematics lessons where guided and independent practice were important. Some STs used more unobtrusive cues, such as noticing that students did not comment at times when the ST expected they would. This will be further explained in the section on expertise.

An interesting theme demonstrated by four STs was their predicting student cues. In their SRIs, the four STs occasionally expressed surprise about a specific student cue or stated that they were consciously looking for a specific response. Both cases suggest that these STs had some idea of what to expect from their students at that point, however inaccurate that idea might be. An example of an unexpected cue was when Sue was "shocked" that her students did not know the meaning of parallel in her second lesson. An example of seeking a specific response was Alex's careful monitoring of her students' reactions in her first lesson when she introduced fables by naming several common ones. When the students reacted by saying, "Oh, yeah!", Alex noted that "I was hoping for a response"(4/3/97) instead of silence because her lesson was built on students' having some familiarity with fables. Regardless of how they were obtained, the presence of these cues

suggested that these STs made predictions about their students' knowledge which they consciously tested during the lesson.

From Whom Cues Were Gathered

Every ST monitored both individual students and the class as a whole. Three sources of cues were used in this assessment: individual students; a few students; and the class, often ambiguously referred to as "they." Cues from the class, of course, were used to determine class understanding. For example, the STs used choral responses or noted how many hands were raised as indicators of class understanding. Cues from a few students were responses from a portion of the class who responded differently from the rest of the students and were noted in the course of assessing the class. Although these cues were rare, it is notable that the STs could note responses different from the majority of the class.

Cues from individual students were used to assess both individuals and the class. An example of an individual cue used to determine just one student's understanding was when Rachel discussed her surprise at one student's knowledge of left and right in her third lesson.

> He's way behind the others in his reading development. But he must know his left from right because he went right to the left page. I thought, "Whoa, that's good!" (4/16/97)

The STs sometimes consciously checked on an individual student's understanding. At times this checking was of students who often had problems with that content. For example, Alex explained in her second SRI that "I watch for them because they're the ones that always require special attention. They go to the paraprofessional for extra help" (4/18/97). Further, some STs deliberately "tracked" an individual's understanding through a lesson. In all of these cases, the individual's cue was interpreted only in terms of that individual's understanding.

Occasionally, STs also used individual cues to decide how the class was progressing. For example, Beth noted the thinking of the class in her second SRI based on one student's response: "They were still thinking of pasta words cause he raised his hand and said

'lasagna' " (5/7/97). In addition, some STs said that if a student who usually performed well in class did not understand, they figured that most of the other students didn't understand either. As Beth expressed it in her first SRI, "Oh, whoa. This kid's not getting it, then I'm not getting it across to a lot of kids" (5/1/97). This example also demonstrates some ST's practice of simultaneously assessing an individual and the class.

An important theme related to source of cues was the ST's reliance upon their knowledge of individual students to gather and interpret cues. The importance of knowing individual students was expressed by Kess in her second SRI when she explained why she randomly called on most of the students as she began that particular lesson.

> I had never worked with this group before. I didn't know what they know, who knows what, any of that. So I was just trying, at this point in time getting a feel for who understands what we're doing right now and who doesn't so I know who to focus on when I do what I'm doing. (4/4/97)

Knowledge of how individual students generally performed was important in assessing individual understanding because it helped the STs know whom to watch during whole class responses and from whom to elicit cues to check their progress. It also allowed them to note who was not performing as usual and determine if they should do further assessment, adjust the lesson, or simply make a note to follow-up with the student later.

Knowledge of individual students was also used to assess class understanding. Some STs knew that the whole class probably did not understand the lesson if students who usually performed well did not understand it. In scanning the class to see who was responding differently from the majority, knowing how individuals typically responded helped the STs interpret the number of hands or responses they observed. Because they knew who never raised a hand or who might not be ready to risk a response at that point, the STs could decide if the number of responses was indicative of class understanding or if other factors were causing a poor response. When some STs noted a poor response for which they did not have an explanation, they conducted further assessments. Finally, the STs' knowledge of their individual students assisted them in predicting their students' responses and consciously checking for them during the lesson.

Interpretation of Cues

The next step for the STs in using student cues was interpreting, or making sense, of them. All of the STs used a variety of types of knowledge to interpret cues to determine student understanding. In addition, some STs used this knowledge to understand and explain their students' thinking. Although all the STs followed a similar process of interpreting cues, they varied greatly in the number and types of knowledge and information they used, the depth of their interpretations, and the extent to which they understood and explained their students' thinking. Further, some STs demonstrated more flexibility in their interpretations by giving multiple explanations, and some also used further assessments to determine which explanation was accurate.

The knowledge and information used by the STs to interpret cues were of several types: general information about the students, the students' prior knowledge and previous performance, the lesson content, common misconceptions for students this age (pedagogical content knowledge), the context of the lesson, and information about previous instruction and students' responses to it. An examination of some STs' cue interpretations will clarify these types of knowledge as well as how some of the STs used this information to go beyond simple determination of understanding or misunderstanding to explain what their students were thinking or to explain why their students responded as they did.

Stefanie interpreted the cues she noted in a relatively straightforward manner, using limited information and knowledge in her interpretations and explanations. For example, in this excerpt from her second SRI, she simply stated that the student was not understanding the lesson and did not explain why he didn't understand it or give further description about how she knew that.

> He wasn't getting it before and like I said he usually does. And I knew he still hadn't gotten it. That's pretty much why I was standing behind him. Because I knew it was just going to be a matter of time until he said, "Help me. I don't get it." And he did. (5/6/97)

Stefanie did use some knowledge and information in gathering and interpreting this cue. She used information about this student's performance earlier in the lesson ("he wasn't getting it") to predict a later response (asking for help). In addition, her knowledge of this student's usual performance was an important factor in focusing her attention on him during the lesson.

An example of deeper cue interpretation and explanation comes from Sue. She generally understood and explained her students' thinking about the content using her content knowledge, her knowledge of the students' prior knowledge, and her pedagogical content knowledge of the conceptions that students of this age usually possess. In this example from her second SRI, Sue asked the students if they had heard the word "parallelogram" before:

> S: Some kids will just say "yeah" no matter whether they've heard it or not because that's the thing to do. Because they don't want to let people know that they've never heard that before. But I think they were pretty honest in saying, "Yeah I've heard that before." But I don't think they made the connection, "I remember seeing that shape and I remember somebody saying parallelogram." I think they made the connection, "Oh, I've heard that word in passing before somewhere back in my education." But they didn't have that figure to attach to that name still.
> R: Now what makes you think that?
> S: Just because that word is just a huge word. And usually when they say "yeah" for some reason they'll give you an example. "Oh yeah, we've studied this shape before," or "I've seen this shape like this and I've heard it called this." You know they'll go in depth a little more into that. And I've had experience with these kids doing that before with science words and they'll give me examples, or at least somebody is making that connection. And with these guys they didn't make that extra connection.

Later, Sue explained more about "parallelogram" being such a "huge word."

> It's such a big word that you usually don't use with kids younger than this age. The biggest thing that you hear is the rhombus which is a parallelogram that's a square. Some kids may have heard of that. (4/21/97)

In this cue interpretation, Sue explained her students' thinking as their remembering having heard of "parallelogram" but not connecting it with the shape. To make this assertion, she used her pedagogical content knowledge about shapes, that students of this age generally have learned about a rhombus but not a parallelogram. She

also drew on her knowledge of these students, that they usually give examples or more explanation when they "make connections." In addition, she used general knowledge of students in knowing that students may recognize a term without understanding it as well as in saying that some students will say "Yes" to avoid having to admit not knowing the answer. Sue's own content knowledge was evident throughout her discussion of this cue.

A third example demonstrates Beth's use of knowledge and information about students and the lesson context to explain student responses, as well as her practice of assessing further when cues were unclear. In this excerpt from her second SRI, Beth explained her reaction to two choral responses. She had asked the class if two lines of a poem rhymed and the first choral response was "yes." Beth's reaction was to say to the class, "It does? Hm."

> [I was thinking] "it doesn't rhyme. Come on guys." I think my first reaction was, and not everybody answered, just a couple said "Uh huh," my first reaction was "Hm." I wanted them to think again. Because I think that, I was hoping at that point that they knew what a rhyming word was. But when I said, "Well, do those words rhyme?" Well because that's all we had done up to that point, they were just expecting the answer to be yes. Maybe some of them. But I hoped I had eliminated that when I said, "Okay now we were talking about poems that don't rhyme." I told them that ahead of time to change their line of thinking at that point. And so when they said, "Uh huh." And I wish I could remember who said that because it might have also been who it was that answered that question as to why I did that. I'm like, "Hm, think again. I know you know this." And if it hadn't been kids who I thought did know it I would have gone, "How come?" and try to figure out "Why aren't they getting this?" But I think I must have gone, "Hm" because I'm thinking that when that happened that the kids that did it knew. I knew they knew because they had been answering questions. And they were just answering to answer. And I think that's why I did that. And then everybody's like, "Well, no." Well, does that mean that they just caught that the answer was no so they all chimed in or did they really know it was no? And then I continued asking questions to make sure that I knew if they were [understanding it]. (5/7/97)

Beth gave multiple explanations for her students' two responses and used several types of knowledge and information to do so. For the students' first response, the incorrect choral "Uh huh," she thought they might have been expecting the answer to be yes because all the previous examples had rhymed, despite the fact that she had alerted them to a change. She also thought that the students were "just answering to answer" without thinking.

The first explanation demonstrated her use of lesson context, what had happened previously in the lesson (the other examples had all rhymed). The second explanation indicated her use of information about students' previous performance in the lesson, because she knew "they knew because they had been answering questions." In addition, her general knowledge of students was apparent in both explanations in her awareness that students sometimes unthinkingly answer out of habit ("they were expecting the answer to be yes") or "just to answer."

Beth also had two explanations for the students' second response, a choral "no." She thought they might have changed their answer simply because her reaction told them that their first answer was wrong, and she thought they might have understood that the words didn't rhyme. In this instance also Beth used her general knowledge of students, that they sometimes "read" the teacher to give the correct response. Because she was unsure how to interpret the students' responses, she conducted further assessments through more questioning.

These examples are representative of the STs' use of different types of knowledge and information in interpreting and explaining cues. Stefanie used knowledge of individual students and awareness of students' performance during the lesson, whereas Sue used information about student performance in previous lessons ("they usually give examples"), pedagogical content knowledge concerning students' usual knowledge at a given age, content knowledge, and general knowledge of students. Beth used information about lesson context, general knowledge of students, and information about their previous performance to explain cues. Each ST showed a unique pattern in the particular blend of types of information and knowledge she used to interpret and explain cues.

These three examples also demonstrate the differences in the STs' attention to and explanations of their students' thinking, which appeared to represent the degree to which they understood their students' thinking. Stefanie simply observed that the student did not "get it," while Sue made a fine distinction between her students' understanding a term and knowing a concept. Beth considered multiple explanations of why her students responded as they did. The STs differed in creating examples of their students' thinking, such as Sue's "quoting" some of her students as thinking, "Oh, I've heard that word in passing before somewhere back in my education" (4/21/97). Sue's and Beth's more

extensive explanations of their students' thinking and more frequent "quotations" of their thinking indicate that they understood their students' thinking more deeply than Stefanie did. The differences in these three STs' understanding and explanation of their students' thinking are representative of the differences among all eight STs in this aspect of cue interpretation.

In addition to these differences in types of knowledge used and depth of understanding of student thinking, the three examples partially demonstrate variations in the depth of the ST's cue interpretations, as indicated by the extensiveness of their explanations of the cues. More extensive cue interpretations included more areas of knowledge and information used in a complex manner, which can be seen in comparing Beth and Sue's examples with Stefanie's. Stefanie simply compared her students' responses to what she wanted them to be. She did not discuss their understanding of the concept, their prior knowledge, or the context of the lesson, as Beth and Sue did. She thought only in terms of what she was trying to teach. Extensiveness of cue interpretation was also demonstrated by use of multiple explanations, further assessments to clarify them, and making and testing predictions about student understanding. For example, Beth twice generated multiple explanations for her students' responses, indicating an ability to consider more than one interpretation of a cue. She also followed up with other assessments to determine which interpretation was correct, evidencing an ability to "think on her feet." Again, the three examples were representative of differences among all eight STs in the depth of their cue interpretations.

Using knowledge and information to interpret cues was part of the basic model employed by all the STs. However, the previously described differences in amount and types of information, depth of understanding of student thinking, and depth of cue interpretation were important in distinguishing levels of expertise in assessing student understanding. These characteristics of practice as well as others will be further explored in the next section which describes expertise in interactive assessment of student understanding.

Second Theme: Characteristics of Expertise in Assessing Student Understanding

Although all 8 STs employed the same basic model for assessing student understanding, the STs differed in several aspects of implementation of the model, including simultaneous assessment of individuals and the class, depth of interpretation of cues, types of knowledge used in cue interpretation, understanding of student thinking, and multiple interpretations of cues. Most of the STs demonstrated isolated practices in these areas which did not form any patterns. However, three STs, Beth, Sue and Hilary, were distinct from the others in that their practices fell into a pattern that indicated possession of greater knowledge as well as more complex thinking. These three STs were determined to be more expert-like than the other STs. A closer examination of their knowledge and practices which demonstrate their complex thinking will provide a description of relative expertise in assessing student understanding while teaching.

As previously mentioned, these three STs used more as well as a wider variety of types of knowledge and information in interpreting student cues. Not surprisingly, these STs also evidenced a deeper understanding of their students' thinking, partially demonstrated through the extent of their interpretations and explanations of their students' cues. In addition, these STs generated more multiple explanations, created further assessments to check them, and predicted student responses more often. These characteristics of complex cue interpretation were indicative of more complex thinking for these three STs than their colleagues in this area of assessment.

Another demonstration of complex thinking was Hilary, Beth, and Sue's ability to screen numerous simultaneous cues and to be aware of unobtrusive ones, such as lack of student response or very quiet student answers. Further, all three STs gathered cues from specific individuals and then simultaneously interpreted them in terms of the student's understanding as well as class understanding. In addition, all three STs demonstrated an ability to "think on their feet" by remembering information gathered during the lesson and using it later in the same lesson to track student understanding or to make an instructional decision.

Hallmarks of these three ST's more complex thinking were their ability to consider several things at once, think on their feet, and integrate many types of knowledge and information while teaching. These practices are indicative of more elaborate, interconnected, and accessible schemata, such as develop as a foundation for expertise (Borko & Shavelson, 1990). Further, these practices demonstrate possession of a template, or mental picture of a typical class (Berliner, 1989), which included information about individual students' usual level of performance and other personal characteristics, as well as information about how this class in particular usually responded, such as knowing they usually asked questions when they didn't understand. This template also included general information about how students of this age respond, such as knowing they are more unresponsive near lunchtime. This template facilitated predicting, noting, and interpreting cues because the STs knew which students to watch and how to interpret common cues.

The previous sections have described knowledge and processes involved in assessing student understanding, including characteristics of relative expertise in this aspect of teaching. How does this knowledge and these processes develop? The next section will discuss the second main area of this study.

Development of Knowledge and Processes in Assessing Student Understanding

A significant finding of this study was that there were not program-based differences in the STs' assessment of their students. All STs developed the same model, and relative expertise in implementing it was demonstrated by STs from both programs. In fact, the most expert-like ST and the least expert-like ST were from the same program and even the same PDS. Since experience in school classrooms was the major difference in the two programs, it is apparent that experience alone was not the prime factor in the STs' learning to assess their students' understanding. Data were collected in this study to explore how the STs developed the knowledge, practices and skills necessary for assessing student understanding.

Interviews with the STs and their cooperating teachers concerning development of the STs' assessment processes revealed that three categories of factors were important in

the STs' learning to read their students while teaching. Program experience factors, the first category, were generally associated with classroom experiences. These factors included experience teaching students, work with the cooperating teacher, observing other teachers, knowledge of the students, and the degree of comfort the ST felt as the teacher of her class, which stemmed from teaching experience. It is important to note that each ST had unique program experiences. For example, some of the STs in both programs had many opportunities to teach students during their field experiences prior to student teaching while others, even those with 385 hours in the PDS classrooms, were limited in their teaching experiences. Similarly, the STs varied in the amount of verbal interaction they had with their cooperating teachers in which the cooperating teacher modeled her thinking about students and discussed her assessment processes, encouraged the ST to gather and interpret cues, and facilitated the ST's reflection on her students and their learning. It was apparent that some STs took more initiative than others in teaching lessons and in prompting discussions with their cooperating teachers. Indeed, one ST from a PDS stated that she "just did what she had to" for her first two semesters and did not become deeply involved in teaching until student teaching.

The second category of factors involved in learning to assess students was experiences prior to the program and included experiences teaching and with children, experiences as a student, observing a teacher, experience reading people, and parenting. Here again the STs varied widely. One ST had taught preschool children for a year, and another had substituted in her mother's private elementary school class. The latter ST had a great deal of observation of teaching and communication with her parents, both of whom were teachers, about hers and their teaching. Two STs were parents, and four STs had very little experience with children or teaching prior to their program. One of the expert-like STs had had extensive practice reading others when, as an aspiring author, she consciously studied strangers' nonverbal language in order to create stories about them. This ST also stated that she understood the responses of her students who were confused because she remembered her responses as a "lost" student who deliberately tried to conceal her confusion. It was apparent that the STs entered their programs with vastly different experiences with children, with teaching, and with varying degrees of focus on assessing student understanding.

The final category was personal characteristics, which included a "natural" rapport with children that was reported by four STs. In addition, one ST, Stefanie, had a tendency to check understanding in ordinary conversation by frequently asking her listener if he or she understood her.

Before explaining how these categories of factors facilitated learning to assess students' understanding, a review of the knowledge, skills and values critical to this assessment is needed. First, the STs needed to value assessing student understanding so that they would consciously gather and interpret cues. Second, they needed practice reading others, which sometimes was adults instead of students. Third, the cognitive space to focus on student understanding of the lesson while teaching, which appeared to be easier when other aspects of teaching were more routine, was important. Most of the STs mentioned that they noticed student cues more as more aspects of teaching became routine. Fourth, they needed to know and use the basic process for assessing students, i.e., eliciting and observing different types of cues from individuals and the class, and interpreting them. Finally, they needed to possess types of knowledge which they could use to interpret the cues and understand the students' thinking. The types of knowledge used included knowledge of individual students, of students in general and of this age, of pedagogical content knowledge of what students this age typically know and misunderstand, and of content knowledge.

Each ST was idiosyncratic in the factors that facilitated her development of these knowledges, values, and practices. For example, Beth's focus on the importance of assessing understanding was a personal value for her while Kess's focus on this was largely developed during student teaching when her cooperating teacher explicitly focused on it and her difficult class "forced" her to assess their understanding to keep them engaged in the lesson. Stefanie's focus on assessing students was a personal value, as indicated by her tendency to check understanding in all conversations, that was reinforced through her program experiences. Despite the individual nature of this development, some generalizations can be made concerning how the categories of factors were important in facilitating development of the knowledge, practices and skills evidenced by the STs.

Besides a focus on assessing student understanding, the STs had various opportunities to practice reading other people or students, individually or as a group.

Some STs specifically mentioned practicing reading others before their programs, such as Beth's discussion of reading nonverbal cues during high school, while others did not consciously practice it until student teaching. It seems that the extended experiences of the PDS program did not necessarily provide more practice in reading students.

Having the cognitive space to focus on assessing student understanding, a prerequisite skill, was expressed by several STs as being less focused on themselves and more focused on their students during their student teaching experience. For some STs, this developed as they felt more comfortable as the teacher and developed more teaching routines. This was probably linked to practice teaching, which occurred prior to the program for a few STs and varied in extent throughout each ST's program.

Practice teaching was also necessary to learn the basic process of observing, eliciting, and interpreting cues. However, modeling of practices and of thoughts as well as feedback from experienced teachers was also mentioned by most STs as important elements in learning to read students. For the STs, observation and discussion of strategies used in assessing student understanding was key.

Finally, learning the various forms of knowledge used in interpreting cues was probably partially learned through discussion with teachers. However, knowing individual students was the most frequently mentioned factor in gathering and interpreting cues. One ST discussed learning to assess an individual's understanding by working with him one-on-one, making inferences about his responses, and then checking on the accuracy of those inferences by looking at his written work. Perhaps the STs generalized from these individual experiences to reading students while in a group. In addition, it is clear that knowing individuals' usual level of understanding was key to interpreting cues for class understanding. Most of the STs discussed getting to know their students through individual and small group work as well as informal interactions, such as at recess.

The knowledge and practices associated with more expert-like assessment of student understanding included more and different types of knowledge and the ability to integrate them in interpreting cues. Additionally, a greater awareness of students and cues as well as the ability to think about several aspects of teaching and assessing simultaneously were important. It is difficult to determine how Sue, Beth, and Hilary developed their deeper

knowledge and complex thinking, but one hypothesis is that Beth and Hilary developed their abilities and knowledge through having a focus on student understanding throughout their greater experiences in classrooms. Both Hilary and Beth entered their programs with a focus on reading others, and both had more extensive practice teaching prior to or during their program. Hilary's practice was as a substitute and through field experiences in her traditional program. Beth's practice was through the extended experiences of the PDS program. This hypothesis further suggests that Sue developed her knowledge and practices through her program, which was quite focused on students' conceptualizations, and her student teaching experience with a cooperating teacher who extensively modeled assessing student conceptualizations. The other STs did not appear to have the same level of focus on assessing student understanding throughout their classroom experiences.

SUMMARY AND IMPLICATIONS

In a constructivist model of teaching, teachers must understand their students' conceptualizations of specific topics being taught, which means they must assess student understanding while they are teaching. This study provides insights into the general pedagogical processes and thoughts of student teachers in assessing student understanding. In so doing, it draws together many findings of previous studies that only tangentially dealt with assessment of student understanding (Berliner, 1987; Lawes, 1987; Leinhardt & Greeno, 1986; Pinnegar, 1989; Martin & Reynolds, 1993; Tan, 1996) and more completely defines this important aspect of general pedagogy.

This study clearly describes the general model of assessing student understanding, which includes focusing on student understanding, gathering varying types of cues from three sources, and interpreting the cues in terms of student understanding. Further, it exposes the thoughts and knowledge necessary for assessing student understanding by defining the general categories of knowledge needed for deep interpretation of cues and describing the complex thinking employed by relative experts. It proposes that this complex thinking is dependent upon knowledge of classroom routines so that cognitive space is available to attend to assessment issues. Through describing the thinking of

relatively inexpert as well as relatively expert student teachers in their assessment processes, it begins to define the developmental stages of this complex thinking. All of this information is valuable in terms of facilitating expertise in assessing student understanding. What is not understood cannot be taught.

This study also begins to explain how these assessment processes and knowledge are learned. It is suggested that the basic assessment process is generally developed through possession of a value for assessing understanding, opportunities to practice assessing others' understanding, knowledge of routines so that cognitive space is available to consider it, opportunities to teach students and practice reading them, communication with experienced teachers in which they model their strategies and thoughts concerning student understanding and encourage similar reflection for the STs, and possession of various forms of knowledge used in interpreting cues. These aspects of learning take place during experiences prior to teacher education programs as well as during the programs, and some are due to personal characteristics of the STs.

It is less clear how the characteristics of expertise, which include wider forms of knowledge that are integrated into more complex thinking and more fluid practices, are developed. The study proposes that stimulating classroom experiences and coursework that were focused on student assessment helped the STs to learn the requisite knowledge, develop a "template" that facilitated gathering and interpreting cues, and develop routines that allowed cognitive space to focus on cues and to integrate forms of knowledge. It is important to note that reflected-upon experience, as suggested by Berliner (1987), is important, but the quality of the experience is critical. Focus on assessment of student understanding, opportunities to teach, and modeling of practices and thoughts by the cooperating teacher are crucial elements of quality experiences.

The preceding summary of the important findings of the study have several implications for teacher education. First, simply extending time in field experiences will not necessarily facilitate learning to assess student understanding. The study suggests that these experiences must be focused, quality experiences that also provide opportunities for preservice teachers to become acquainted with individual students. Second, teacher education programs need to focus on developing the kinds of knowledge used in interpreting cues and to provide modeling and practice in integrating them into classroom

practice. Third, programs must provide the knowledge, experiences, and values not supplied by personal characteristics and prior experiences. The teacher education program is not the only factor in the STs development of processes for assessment of student understanding, and it must build upon the entering PT's characteristics and experiences.

Many questions remain concerning the development of skill in assessing student understanding. What is the role of coursework in building knowledge used in interpreting cues? Although most of the STs did not mention coursework, it seems likely that courses that focused on child development and learning theory would provide basic information about students used in interpreting cues. In addition, content courses would seem necessary to develop the content knowledge prerequisite to understanding student conceptualizations. For one expert-like ST, coursework which focused on student conceptualizations prompted her to secure a student teaching experience which provided explicit focus, modeling, and practice in assessing student understanding during instruction. This coursework and student teaching experience were crucial in developing her skills and knowledge since she entered the program with few experiences. An exploration of where and how PTs learn the knowledge used in interpreting cues would assist both preservice and inservice teacher education in facilitating development of such knowledge for teachers. Such research could have significant impact on proposals to draw together schools of education and colleges of liberal arts and sciences (Goodlad, 1994).

Another area for investigation is what factors prompt the development of the complex thinking patterns of the relative expert. Beyond a logical supposition that highly developed knowledge and the formation of routines and a mental template could facilitate consideration and interpretation of cues, this study did not establish how and why the expert-like STs were able to integrate forms of knowledge into deep interpretations while simultaneously managing all other aspects of teaching. How did these STs develop their "mental templates?" What prompted them to integrate various forms of knowledge into complex cue interpretations? Is there a personal factor, such as tendency to integrate information and think deeply, that influenced this complex thinking? Answers to such questions could provide valuable insights into how to stimulate more complex thinking for experienced as well as beginning teachers.

Finally, is there an interplay between personal readiness to learn to teach and provision of opportunities to do so in facilitating progress toward expert-like teaching? The three expert-like STs showed initiative in taking advantage of opportunities to teach throughout their program, and they also indicated a focus on assessing student understanding prior to student teaching. In contrast, one of the PDS STs stated that she did not focus on her students' understanding until her difficult class forced her to do so. Similarly, another of the PDS STs remarked that she only did "what I had to to get by" in her field experiences until student teaching. Perhaps time in classrooms is of little value until the preservice teacher is ready to take advantage of it. On the other hand, perhaps some preservice teachers need such experiences to become ready to learn to teach. Information on this topic would be helpful in determining when and why to provide field experiences for preservice students.

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